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8-15-1997

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Recommended Citation

Zhang, Ping and Massad, Nelson, "The Impact of Animation on Individual Performance: A Web-Based Experiment" (1997). *AMCIS 1997 Proceedings*. 277.

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The Impact of Animation on Individual Performance: A Web-Based Experiment

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Introduction

Multiple presentation modes, or multimedia, have become a very common feature of user interfaces, especially web pages. For example, text, graphics, and images may all appear on one screen during a user's information seeking and processing. When surfing the Internet using a web browser, one can easily access many pages with vivid animation jumping on the screen. Certainly animation enriches the web pages, and rapid development of web design facilities makes web pages more colorful and even more attractive. On the other hand, since human peripheral vision is very good at perceiving moving objects, animation may also cause visual interference that affects information seeking performance. For example, one may find that it is hard to concentrate on the pertinent information when there is an animation around the information. Thus it may take longer to get the information correctly.

Few research results can be found that report animation effects on individual information seeking and processing performance. Thus it remains questions whether animation can really decrease performance and to what extent animation affects one's performance.

In this paper, we report a study that answers these two questions. The study is believed to be valuable in guiding web page designers to use animation carefully in web environments. The study also suggests that the designers of any type of user interfaces should consider possible visual interference sources that may affect an individual's performance.

Research Hypotheses

The research is designed as a focused attention task (Eysenck & Keane 1995). Participants are to count how many times a target string appears in a given table of strings (attended stimuli) on a web page. A string is a random combination of one to four letters. Animation (unattended stimuli) is added to the web page. The correctness of the answers and the time spent to get the answers are then used as measures of performance.

In this study, animation is designed to provide no extra information for the user's information seeking tasks. According to Allport (1989), the meaning of unattended visual stimuli is generally processed. It is very likely that animation causes visual interference and thus affects the individual's visual information seeking performance. This is our first hypothesis.

- Hypothesis #1. If an animation does not provide useful information for a user's information seeking and processing tasks, it will deteriorate the participant's performance.

Literature also indicates that the degree of interference has to do with the similarity of the distracter and the attended stimuli. The more similar they are, the greater the interference is. In our case, we introduce some animation that has similar content with a user's task (moving strings) and some that has absolutely nothing to do with the tasks (arbitrary images). We believe that:

- Hypothesis #2. Animation that is similar to a task has more negative impact on performance than animation that is not similar to the task.

According to Lavie (1995), a distracter has less impact on a more difficult task than on a simple task. In her study, participants were asked whether a target letter appeared in a string of one or six letters after the string was exposed for 50ms. The one letter condition was called a simple task, the six letter condition a difficult task. Lavie argued that a difficult task required participants' more cognitive effort, thus their cognitive capacity was utilized with less room left for processing irrelevant information (that is, distracter).

We believe that Lavie's finding can be applied to the web based tasks. In order to test this, we divide tasks into simple and difficult ones. After some trials, we found that one letter strings are too easy to count, and any string with more than four letters is extremely difficult to work with. We decide that in this study, a simple task is a target string with two letters, and a difficult one is a target string with four letters. The corresponding hypothesis is:

- Hypothesis #3. As the difficulty of the task increases, the participant's performance will be less affected by the animation.

Hirohiko Mori and Yoshio Hayashi (1995) studied the impact of peripheral windows on information seeking performance. They found that a peripheral window caused more interference when it was closer to the task than when it was farther away from the task. The implication of this conclusion is that distance may have an effect on the interference and thus affects a participant's performance. We wonder if this is also true for the web based tasks. In this study, we carefully arrange the location of the target strings in the table so that all the target strings in one table can be considered either within a small distance from the animation or large distance.

- Hypothesis #4. Animation has a stronger negative effect on a participant's performance if it is closer in space to the target strings than if it were further away from the targets strings.

Another factor we consider is the color of animation. We believe that animation with bright color makes it more noticeable and thus more distracting than animation with dull color. This is our last hypothesis about the impact of animation:

- Hypothesis #5. Animation with bright color has a stronger negative effect on a participant's performance than animation with dull color.

Table 1 lays out the four factors in this study, plus the baseline condition where no animation is used in the web pages. Each of the 20 tables represents one unique combination of conditions. Tables 03, 06, 17 and 20 are used as practice tables with different target strings.

Experiment and the Results

Participants are 24 undergraduate students in Information Management and Technology major. They all have web use experience. The incentives include three level prizes at \$30, \$10 and \$5, and a bonus for a course the participants are taking (either substitute an assignment, or get extra credit). The experiment uses repeated measures, thus each participant does a total of 20 tables. Each participant has a unique sequence of tables which is pre-defined by the experimenters with consideration for reducing the potential order effect.

The computers used in the study are SPARC stations with 19 inch monitors. The web browser is Netscape Navigator Gold 3.01. The background color of all web pages is the default color, which is gray. The foreground color is black. The string table is 10 rows by 8 columns of randomly generated arbitrary strings of one to four letters. The target strings can appear from one up to five times on the tables. Prior to a table page, a so called "break page" shows what the target string for the next table is and a link to the table page. The table page (with or without animation) has the table of strings in the center of the screen, and an answer selection session at the bottom of the screen. The participant can select an answer and click the "Submit" button, which leads the participant to the next break page in the sequence. The size for all animations remains the same: 1.5 square inch on screen. The small distance is set as within 2 inches on screen measure, and the large distance is beyond 3 inches on screen measure.

Participants are told that both break pages and tables pages have a limited duration and disappear from the screen when time is up: a break page lasts 10 seconds and a table page lasts 20 seconds. They are also told that their performance score is determined by the time they spend on 20 tables pages and the number of correct answers. Both the time and the correctness are captured by the server. The participants have a practice session with four tables indicated in Table 1 before the competition starts.

The performance score of a table is calculated by the following formula:

$$p_score = (CntAccuracy + 1 - Time/Longest) * 1000$$

where CntAccuracy is calculated by $(1 - \text{abs}(\text{CorrectCnt} - \text{SelectedCnt}) / \text{CorrectCnt})$, and the Longest is for this table among all the participants.

Table 2 shows the paired t-test results. Of the five hypotheses, three are confirmed by the study. In general, the performance of baseline conditions are significantly higher than the performance at animation conditions. Animation does affect one's information seeking performance. It is also true that animation has different impacts on different level tasks. The more difficult the task, the less distracting the animation, and the higher the performance score. The color plays an important role in affecting one's performance. Bright color (green, orange, red, bright blue) animation worsens significantly more performance than dull color (gray, black, white).

There is no difference found for similarity or distance. Further study is needed on similarity impact. Since a participant has to go through the entire table to search for the target string, and the animation is placed on the border of the table, the distance from the margin of the animation to all target strings in the table may not be the proper design to test the distance effect. An alternative design would be to control the distance between the animation and the table. Also, the difference between small distance and large distance may need to be enlarged in future studies.

Conclusions

The primary goal of this study is to test if animation is a source of visual interference and to what extent animation affects one's information seeking performance. In order to achieve this goal, many factors have been eliminated from this study. For example, the speed of an animation, many potential locations of an animation (for instance, an animation inside the table), and the size of animations are not considered in this study and will be in future studies.

The direct implication of the study results is that the designers of web pages and other user interfaces need to be aware of animation as the source of visual interference. Among several purposes of animation in user interfaces, such as decorating, drawing attention, and visual explanation, one should examine carefully the purpose of the entire web page or interface and the need to use animation.

References

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Table 1. A Structure of the Study.

| | | Animation Similar to Tasks | | Animation Dissimilar to Tasks | | |
|--|----------------------------|-------------------------------|-------------------|----------------------------------|-------------------|--------|
| | Baseline (no animation) | Small Distance | Large Distance | Small Distance | Small Distance | |
| Simple Tasks | 01 | 03 * | 05 | 07 | 09 | dull |
| Difficult Tasks | 02 | 04 | 06 * | 08 | 10 | color |
| Simple Tasks | 11 | 13 | 15 | 17 * | 19 | bright |
| Difficult Tasks | 12 | 14 | 16 | 18 | 20 * | color |
| *also used during the practice session with different target strings | | | | | | |

Table 2. Paired t-Test for Means

| | Mean | Variance | Obv. | df | t | p |
|----------------|---------|----------|------|----|--------------|------------|
| Baseline | 1196.39 | 20038 | 24 | 23 | 4.5125 | .000 *** |
| Animation | 1073.74 | 17987 | 24 | | | |
| Simple Task | 1014.27 | 30430 | 24 | 23 | -3.4048 | .002 ** |
| Difficult Task | 1133.20 | 20184 | 24 | | | |
| Similar | 1097.10 | 26821 | 24 | 23 | 1.3720 | .183 |
| Dissimilar | 1050.37 | 23072 | 24 | | | |
| Dull Color | 1146.11 | 22785 | 24 | 23 | 4.8559 | .000 *** |
| Bright Color | 1001.36 | 23851 | 24 | | | |
| Small Distance | 1082.70 | 26345 | 24 | 23 | 0.5333 | .599 |
| Large Distance | 1064.78 | 23184 | 24 | | | |
| | | | | | *** p < .001 | ** p < .01 |